SYSTEM AND METHOD FOR TRANSMITTING SIGNALS

FIELD OF THE INVENTION

[0001] The present invention generally relates to communication systems and more specifically to a system and method for transmitting audio and/or video information in a digital form over a digital network.

BACKGROUND OF THE INVENTION

[0002] With the increase in the number of consumer electronic devices, the method for communicating between devices has become more complicated. For example, the number of components of a home audio system that communicate with one another has greatly increased. Wires are used to transmit audio and/or video signals between the components. In this regard, the wires are connected between components that generate the signals such as receivers and CD/DVD players to the devices that play the signals such as televisions and speakers.

[0003] As will be recognized, the wiring for an audio/video entertainment system having multiple components can be very cumbersome and expensive to implement. The typical audio/video system may have multiple components such as cable/satellite TV receivers, CD/DVD players, VCR's, game stations, audio amplifier, television, speakers, etc.... Each of these devices needs to be wired into the system for full functionality.

[0004] Furthermore, it is becoming more common to integrate a personal computer into the entertainment system for storing audio and video data in a digital format. Usually, the content is transferred from the computer to an amplifier of the home entertainment system in order for playback. Often times, the computer is not located with the other components of the home entertainment system and running wires to the other components of the entertainment system is

1

cumbersome. Many times, the computer system is integrated into a home network. The network can be wired (i.e., Ethernet) or wireless (i.e., Bluetooth or IEEE 802.11).

[0005] Currently, it is difficult to use the network to transfer the information from the home computer to the other components of the entertainment system. A special adaptor or other device must be used to integrate the analog components with the network. The adaptor must be able to receive signals from the network and convert the signals to an analog format. Furthermore, the computer and the adaptor should be programmed to determine the device that will receive the signals.

SUMMARY OF THE INVENTION

[0006] There is a need for a device which can easily integrate electronic devices such as components of an entertainment system. Such a device can reduce the number of wires thereby facilitating integration. Furthermore, it would be advantageous if such device can use an existing computer network to connect components in a seamless manner.

[0007] In accordance with the present invention there is provided a system for communicating data between electronic devices. The system has at least one transmitter in electrical communication with a sending electronic device. The transmitter has a data sum accumulator, a transmitter identification generator, and a data buffer for creating an identification of a desired receiver from the sum of the incoming data. Furthermore, the system has at least one receiver in communication with a receiving electronic device. The receiver has a data sum accumulator, a data buffer and a receiver identification generator for creating an identification of a desired receiver from the sum of incoming data sent by the transmitter.

[0008] The transmitter can further include an analog to digital converter for converting the signal from the sending device into digital format. Furthermore, the transmitter may also include

an encryption unit for encrypting data and a compression unit for compressing data. Similarly, the receiver may have a digital to analog converter for converting the data sent by the transmitter into an analog signal for the receiving device. Furthermore, the receiver may include a decryption unit for decrypting the data and a decompression unit for decompressing the data.

[0009] In accordance with the present invention, each transmitter has a unique transmitter embedded ID. The data is first summed and then an extra data is created in such a way that a unique receiver ID is created for the intended receivers. One extras data is also added (in addition to the extra data for the regular receivers in order to generate a unique receiver ID for the adaptor, bridge, hub our router. The regular receiver will not count this extra data for the adaptor, bridge, hub router when checking for the ID.

[0010] A classification code can be added to the receiver ID in order to differentiate the ID type. Different receivers can optionally share the same receiver ID. A receiver will only accept received data when there is a matching receiver ID of the same type. The data accepting or rejecting mechanism is done without any switching processor or module.

[0011] The transmitter can also auto-stop transmitting when there is no incoming signal activity over a set period of time and auto-wake to transmit when an incoming signal is detected. The receiver can also auto-shutdown the data output and/or digital to analog converter when there is no incoming data over a set period of time and auto-wake to transmit data and/or turn on the digital to analog converter when it receives data.

[0012] The data buffer design for both the transmitter and the receiver prevents data under-flow and over-flow conditions. When data under-flow and over-flow conditions cannot be prevented, a graceful audio and/or video concealment can be performed. If the above effort is not done, the data buffer design will allow data under-flow and over-flow conditions to occur and recover to normal operations later.

3

[0013] The ID's for the transmitter and receive can be either manually or automatically assigned as long as the ID's are unique among transmitters and receivers. In manually setup mode, different receivers are allowed to share same receiver ID's. The automatic assignment mechanism for the transmitter is to first detect all of the transmitter ID's from all of the data received over a set period of time. Then the transmitter will assign itself a unite transmitter ID that is different than from any of the ID's detected. The transmitter will broadcast the transmitter ID and wait for a conflict response. If there is a conflict, a new unique transmitter ID will be assigned. The automatic assignment mechanism of the receiver is similar except that the receiver ID needs to be transmitted by a transmitter. A dedicated receiver ID can also be used for time stamp synchronization. In addition to the foregoing, it is also possible to include error detection and/or a correction unit can be added to the design to safe guard the data.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These, as well as other features of the present invention, will become more apparent upon reference to the drawings wherein:

[0015] Figure 1 illustrates electronic devices networked together using the present invention;

[0016] Figures 2–19 are block level diagrams illustrating different embodiments of the present invention;

[0017] Figures 20-26 illustrate network configurations utilizing the present invention; and

[0018] Figures 27-32 are bit diagrams illustrating the operation of the present invention.

DETAILED DESCRIPTION

[0019] Various aspects will now be described in connection with exemplary embodiments, including certain aspects described in terms of sequences of actions that can be performed by elements of a computer system. For example, it will be recognized that in each of the

4

embodiments, the various actions can be performed by specialized circuits or circuitry (e.g., discrete and/or integrated logic gates interconnected to perform a specialized function), by program instructions being executed by one or more processors, or by a combination of both. Thus, the various aspects can be embodied in many different forms, and all such forms are contemplated to be within the scope of what is described. Programming instructions can be embodied in any computer readable medium for use by or in connection with an instruction execution system, apparatus, or device, such as a computer based system, processor containing system, or other system that can fetch the instructions from the instruction execution system, apparatus, or device and execute the instructions.

[0020] As used herein, a "computer-readable medium" can be any means that can contain, store, communicate, propagate, or transport the program for use by or in connection with an instruction execution system, apparatus, or device. The computer-readable medium can be, for example but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, device, or propagation medium. More specific examples (a non exhaustive list) of the computer readable-medium can include the following: an electrical connection having one or more wires, a portable computer diskette, a random access memory (RAM), a read only memory (ROM), an erasable programmable read only memory (EPROM or Flash memory), an optical fiber, or a portable compact disc read only memory (CDROM).

[0021] Referring now to the drawings wherein the showings are for purposes of illustrating preferred embodiments of the present invention only, and not for purposes of limiting the same, Figure 1 illustrates a home entertainment system 10 utilizing the present invention. The entertainment system 10 has an antenna 12 capable of receiving either digital and/or analog signals that are transmitted to entertainment components 14 such as an audio receiver, satellite receiver, cable TV receiver, DVD player, CD player, DVR, game station, VCR, amplifier,

etc.... The number and type of components can vary upon the choice of the user. The components 14 are electronic devices that can generate either analog or digital electronic signals. The entertainment system 10 may also include a television 16 for displaying video from signals generated by the audio components 14. For example, the television may generate a picture from analog signals for conventional television or generate a picture from digital signals for a digital television. The system further includes speakers 18a, 18b for generating audio from audio signals of the components 14. The number and type of speakers can vary upon the choice of the user. The entertainment system 10 may further include a computer system 20 for storing and organizing digital media files. The computer system 20 can store MPEG and AVI files that can be played by the components 14.

[0022] As previously mentioned above, the devices of the entertainment system 10 are typically connected through the use of wires and can be very cumbersome because many wires are needed. Specifically, wires are needed between the antenna 12 and the components 14, while the speakers 18a, 18b and television 16 are also connected to the components 14 with the wires. With each electronic device of the entertainment system 10 having the present invention, the need for wires can be eliminated. Specifically, the present invention provides an transmitter or a receiver for connecting the devices in an efficient manner.

[0023] Referring to Figure 2, a block diagram for an analog transmitter 22 constructed according to the present invention is shown. The analog transmitter 22 is configured to receive analog signals from an electronic device such as the electronic components 14 that are sending signals to other components. The transmitter 22 includes an analog to digital converter 24a for converting an analog signal 26a into a digital signal as is commonly known. For example, the analog to digital converter 24a can sample the incoming analog signal at a prescribed rate and generate the corresponding digital signal such as an 8-bit/sample.

[0024]   The digital signal from the analog to digital converter 24a is fed into a data buffer 28a and a data sum accumulator 30a. The data buffer 28a stores the digital data while an identification is generated, as will be further explained. Referring to Figure 32, the data sum accumulator 30a sums all of the bits from the analog to digital converter 24a together. The number of bits of data the accumulator 30a generates is equal to the number of bits as the address of the desired receiver. The output of the accumulator 30a is fed into the receiver ID generator 32a which takes the two's complement of the data. Furthermore, the ID generator 32a adds the address of the identification of the receiver to the data, as seen in Figure 28. The receiver ID is chosen by the user and is the device that is to receive the data. For example, referring to Figure 1, if the user wanted to send audio data from the electronic components 14 to the speakers 18a or 18b, the user would select the address of the corresponding speaker 18a/18b on the transmitter 22 of the components 14. The output of the receiver ID generator 32a corresponds to the address of the desired receiver.

[0025]   A network protocol generator 34a receives the data from the data buffer 28a and the addressing information from the receiver ID generator 32a. The protocol generator 34a combines and converts the data from the data buffer 28a and the receiver ID from the receiver ID generator 32a into a format for transport over a network. For example, if the data is to be transported over a WiFi IEEE 802.11 network, the network protocol generator 34a would convert the data into the appropriate format. The network can be either wired or wireless, as long as the transmitter and receiver are both using the same format. Some non-limiting examples of networks are Ethernet (10/100/1Gig, etc...), Bluetooth, Firewire (1394a&b), USB, and Fibre Channel. The network protocol generator 34a outputs the formatted data to the network physical layer 36a for transmission over the network.

[0026]   Referring to Figure 5, a block diagram for an analog receiver 38 is shown. The analog

receiver 38 generates an analog signal 26b that corresponds to the inputted analog signal 26a of

the transmitter 22 of Figure 1. The signal from the transmitter 22 is received over the network at

the network physical layer 36b. A network protocol generator 34b converts the incoming data

stream into the data sent by the network protocol generator 34a of the transmitter 22. In this

regard, the network protocol generator 34b is similar to the network protocol generator 34a

because it can convert the data back to its original format.

[0027]   The process of determining the ID of the receiver from the data is the inverse of the

process of generating the ID. The output of the network protocol generator 34b is fed into a data

buffer 28b and a data sum accumulator 30b. The data sum accumulator 30b sums the incoming

data and generates a 31bit data stream. As seen in Figure 29, the data stream can be expanded to

32 bits by padding the most significant bits (MSB) with 0. The receiver ID generator and

checker 32b adds the sum from the accumulator 30b with the data received from the network.

By adding the data and the sum together, the identification of the targeted receiver is generated.

The receiver ID generator and checker 32b compares the identification of the receiver 38 with

the generated identification from the network to determine if the data stored in the data buffer

28b is targeted for that receiver. If the identifications match, then the data is released from the

buffer 28b. However, if the identifications do not match, then the data contained in the buffer

28b is not released. From the data buffer 28b, the data is sent to a digital to analog converter 40

to convert the digital data into the analog signal 26b.

[0028]   In addition to the foregoing, it is also possible to transmit and receive digital signals

directly. Referring to Figure 3, a digital transmitter 300 for transmitting digital signals directly

over the network is shown. The digital transmitter 300 is similar to the analog transmitter 22

inasmuch as the elements and methods of generating the receiver ID are the same. However, the

digital transmitter 300 does not have the analog to digital converter 24a of the analog transmitter

22. Therefore, the operation of the digital transmitter 300 is identical to the analog transmitter 22

except for the conversion of the input signal into a digital format. The digital signal 42a is

inputted into the data buffer 28a and the data sum accumulator 30a directly. Referring to Figure

4, the digital receiver 400 used to receive the signals from the digital transmitter 300 is shown.

The digital receiver 400 is similar to the analog receiver 38 except that it does not have the

digital to analog converter 40. In this regard, the digital receiver 400 directly outputs a digital

signal 42b. It will be appreciated by those of ordinary skill in the art, that any combination of the

analog transmitters and receivers 22, 28 and digital transmitter and receiver 300, 400 can be used

because the components are nearly identical. For example, if the input source of the signal is an

analog device and the device receiving the signal is a digital device, then an analog transmitter

22 would be connected to the input device, and a digital receiver 400 would be connected to the

receiving device.

[0029]   Referring to Figure 6, an analog transmitter 600 with encryption is shown. The

transmitter 600 has the ability to encrypt the signal to be transmitted. The transmitter 600 is

similar to the analog transmitter 22, but includes an encryption unit 602. In this regard, the

analog signal 26a is converted to a digital signal with the analog to digital converter 24a. The

encryption unit 602 encrypts the digital signal before inputting it to the data buffer 28a and the

data sum accumulator 30a. The encryption unit 602 can apply any type of encryption standard to

the signal. The encrypted signal is then processed by the data buffer 28a, data sum accumulator

30a, receiver ID generator 32a and network protocol generator 34a as previously explained.

Figure 7 illustrates the corresponding receiver 700 for receiving and decrypting the signal. The

receiver 700 is similar to the analog receiver 38 shown in Figure 5, but includes a decryption unit

702. In this regard, the signal stored in the data buffer 28b is decrypted by the decryption unit

702 before being converted into a digital signal by digital to analog converter 40. As will be recognized by those of ordinary skill in the art, the encryption unit 602 and the decryption unit 702 will utilize the same encryption format for proper operation.

[0030]   Referring to Figures 8 and 9, an all digital implementation of the receiver and transmitter with encryption are shown in Figure 8. A digital transmitter 800 with encryption is shown. The transmitter 800 is similar to the analog transmitter 600 of Figure 6 except that it does not have the analog to digital converter 24a. Similarly, a digital receiver 900 is shown in Figure 9 and is similar to the analog receiver 700 of Figure 7 without the digital to analog converter 40. As will be appreciated by those of ordinary skill in the art, the analog transmitter 600 and receiver 700 can be used with the digital transmitter 800 and receiver 900 in any combination depending upon the application.

[0031]   In addition to the foregoing, it is also possible to compress the signal before transmission. Referring to Figures 10 and 11, an analog transmitter with compression 1000 and an analog receiver with compression 1100 are shown respectively. The transmitter with compression 1000 includes a compression unit 1002 to compress the signal before processing. Similarly, the receiver with compression 1100 has a decompression unit 1102 that decompresses the signal after processing. Both the compression unit 1002 and the decompression unit 1102 need to use the same format for compressing and decompressing the signal. Figures 12 and 13 illustrate all digital implementations of the transmitter 1000 and receiver 1100 respectively. Specifically, the transmitter 1200 does not have the analog to digital converter 24a, while the receiver 1300 does not have the digital to analog converter 24b.

[0032]   It is also possible to use both encryption and compression with the receivers and transmitters. Referring to Figure 14, an analog transmitter 1400 with both encryption and compression is shown. The transmitter 1400 includes a compression unit 1002 for compressing

the signal from the analog to digital converter 24a and an encryption unit 602 for encrypting the compressed signal. Similarly, the receiver 1500 has a decryption unit 702 for decrypting the signal from the data buffer 28b and a decompression unit 1102 for decompressing the decrypted signal. All digital implementations of a transmitter 1600 and a receiver 1700 with compression and encryption are illustrated in Figures 16 and 17, respectively.

[0033]   An adaptor 1800 for connecting devices into a computer network is shown in Figure 18. The adaptor 1800 can both send and receives signals being sent over the computer network. In this regard, the adaptor 1800 configures the signals to be received by a receiver of the present invention. The adaptor 1800 has a network protocol generator 34a which formats the signals for the prescribed network. A data buffer 28b, a data sum accumulator 30b and a receiver ID generator 32b format the signals to be received by an appropriate receiver attached to the computer network. A computer network MAC layer 1802 interfaces with the computer network physical layer 36a to control and transfer the signals in the network protocol over the computer network. Similarly, signals from the computer network MAC layer 1802 are processed by data buffer 28a, data sum accumulator 30a, and receiver ID generator 32a before being inputted into the network protocol generator 34a for transmission over the computer network. In this regard, the adaptor 1800 can add the receiver ID to signals for receipt by receivers.

[0034]   A router 1900 for distributing signals over computer networks is shown in Figure 1900. Signals are received by either of the network protocol generators 34a, 34b. A data buffer 28b and data sum accumulator 30b receive data from the network protocol generator 34a and hence network "a". A receiver ID generator 32b decodes the address identification of the incoming data. If the identification of the data matches the identification of network "b" as determined by the receiver ID generator 32b, then the data from the data buffer 28b will be transmitted to the network protocol generator 34b and hence transmission over the computer network "b". If the

identification does not match, then the data will not be transmitted from the data buffer 28b.

Similarly, the data buffer 28a, data sum accumulator 30a and receiver ID generator 32a check the

identification of data from network "b". The data will be released if the identification matches

the identification for network "a" as determined by the ID generator 32a. In this regard, it is

possible to route data that has been formatted by transmitters of the present invention to receivers

on another network.

[0035] A block diagram showing how a transmitter unit 2004 communicates with receiver

units 2006a-2006e with a repeater is shown in Figure 20. The transmitter unit 2004 can be any

of the analog or digital transmitters previously described, while the receiver units 2006a-2006e

are any of the receivers previously described. The repeater unit 2002 is a device that repeats the

data from the transmitter unit 2004 as is needed when transmitting over long distances.

[0036] Referring to Figure 21, a network using adaptor unit 1800 is shown. In this instance,

the adaptor allows the transmitter unit 2004 to connect to the computer network. Also shown in

Figure 21 are receiver units 2006a-2006c that can receive data directly from the transmitter unit

2004.

[0037] The configuration of a router unit 1900 in a network is shown in Figure 22. The router

unit 1900 connects network "a" to network "b" and allows data to pass therebetween. Therefore,

data from transmitter unit 2004a can be received by receiver units 2006c and 2006d if the

identification of the data matches the identification of the receiver units 2006c, 2006d as

determined by the router unit 1900. Accordingly, the router unit 1900 allows the data to cross

between network "a" and network "b".

[0038] Figure 23 illustrates how the combination of devices can be connected to deliver audio

and video content over a computer network. A computer network unit 2300 interfaces with the

computer network (wired or wireless). Adaptor units 1800a and 1800b convert the data from the

computer network into the format that can be received by the receiver units 2006a-2006d, as previously described. Furthermore, the adaptor units 1800a and 1800b convert the data from respective transmitter units 2004a and 2004b for transmission through the computer network unit 2300. Figure 24 is similar to Figure 23, but includes a router unit 1900 for routing the data over the networks.

[0039] The number of receiving units is not limited by the size of the network. Figure 25 illustrates the situation where multiple receiving units 2006a to 2006(N) are connected to the network. The number of receiving units is only limited by the number of identifications available. Figure 26 shows an example similar to Figure 25 whereby two networks are connected together.

[0040] It will be appreciated by those of ordinary skill in the art that the concepts and techniques described here can be embodied in various specific forms without departing from the essential characteristics thereof. The presently disclosed embodiments are considered in all respects to be illustrative and not restrictive. The scope of the invention is indicated by the appended claims, rather than the foregoing description, and all changes that come within the meaning and range of equivalents thereof are intended to be embraced.